Clouds 1 Report

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I. INTRODUCTION

This report documents the physics of a cloud and the photography techniques used to capture a cloud image for the first of two cloud experiments of the Flow Visualization course at the University of Colorado at Boulder. The goal of this document is to describe the atmospheric sounding conditions and camera settings used to photograph the altocumulus-type cloud presented on the cover page (p. 1).

II. CLOUD PHOTOGRAPHY PROCESS

The cloud photo presented on p. 1 was chosen among over 180 photos taken for the assignment. The cloud described in this report was imaged just west of the Rocky Mountain Metropolitan Airport (A.K.A. Jefferson County Airport, 39°54′32″N 105°07′02″W) on January 28, 2011 at 1:18 PM. A sampling of various clouds photographed at this time is presented below.

Figure 1. Clouds photographed January 28, 2011 at 1:18 PM.

The third cloud photo in Figure 1 was chosen for analysis for two reasons: 1) the aesthetically pleasing flatness and smoothness of the clouds and 2) the unique feather-shaped cloud near the left side of the photo, likely caused by a dissipating condensation trail or contrail of a passing airplane. Figure 2 shows a separate photo taken as a close up of the feather cloud.

Figure 2. Close up of feather-shaped contrail.

The third photo in Figure 1 was located due west of the airport just over the Rocky Mountain Foothill mountain range. The camera lens was positioned approximately 45° from the horizon.

III. CLOUD DESCRIPTION

a) Cloud Type

The clouds photographed on p. 1 as well as the third image in Figure 1 (aside from the contrail) can be classified as the altocumulus genus of the lenticularis species due to its individualized lens-like shape. Although the sun or moon is not visible in the photograph, it is speculated that the variety of the altocumulus is translucidus because of the very thin edges of the cloud[1]. Altocumulus clouds are often referred to as 'mountain wave clouds' because they are formed from cool air rising that is forced to pass over an obstacle such as a mountain. Because the photo was taken just over the Foothills lends further argument to classifying the cloud as an altocumulus. It is speculated that the composition of the clouds in question is mostly water vapor as opposed to ice crystals which are also possible in an altocumulus cloud.

b) Weather Conditions

The weather at the time of the photo chosen was clear and calm. Except for the patches of clouds photographed, the sky was very transparent and blue as shown in Figure 1 and had been for several hours before and after 1 PM. No wind was apparent at ground level and no precipitation was present at the time of the photograph. The ground level air temperature was measured to be 63 °F.

c) Atmosphere Stability

Figure 3 shows the skewed temperature or skew-T plot for 6 PM weather in Denver on January 28, 2011 which represents the closest available sounding data to 1 PM on January 28. The dark black lines in the plot represent measured temperature data (right line) and dew point data (left line) versus altitude, pressure, temperature and known adiabatic conditions. The data for this particular date and time suggest clouds forming at just over 5700 m (18,696 ft or 3.5 mi) elevation because the dew point and measured temperature are closest in proximity. This altitude confirms that the clouds spotted are altocumulus-type which typically forms between 6,500 and 18,000 ft.

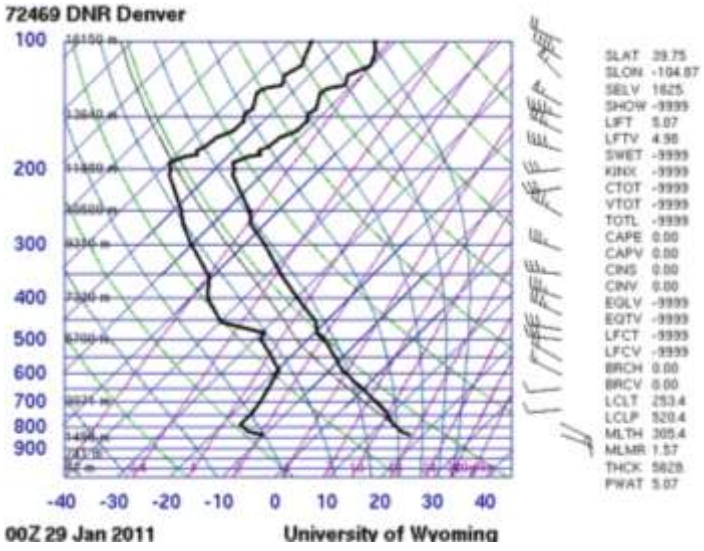

Figure 3. Skew-T plot for 6 PM weather data in Denver, Colorado[2]

From the data the atmosphere appears to be stable. The air temperature decreases with elevation as expected at a faster rate than the saturated adiabats (curved blue lines) until cloud formation at 5700 m. The CAPE index (stands for Convective Available Potential Energy) of zero in the plot also suggests a stable atmosphere which means that the parcels of measured air did not transfer much heat into the surrounding air as the molecules were cooling during expansion while rising.

IV. PHOTOGRAPHIC TECHNIQUES

a) Camera Settings

The altocumulus cloud was photographed using a 14.1 megapixel Panasonic Lumix DMC-FZ100 digital camera. According to the elevation of the clouds calculated in Section 3, the location of the camera lens to the clouds was approximately 5700 m. A focal length of 13 mm was used; the telephoto zoom on the FZ100 was used in order to reduce the field of view at this altitude. The field of view is approximated to be on the order of tens of miles. A fast exposure speed 1/2000 s was used to capture the fluid movements of the clouds and because ample ambient lighting was provided from the overhead sun. An f-stop or aperture size of f/4 and an ISO setting of 100 were used to gather as much natural lighting from the cloud as possible.

b) Image Post Processing

Adobe Photoshop CS5 was used for post processing of the cloud image. The original 4320 x 3240 pixel JPEG image was imported into Photoshop to begin post processing. The image was then cropped to 5174 x 1935 pixels in order to remove any unwanted sky and mountaintops and to make the cloud symmetric with the sky from top to bottom. The 'With Perspective' option was used when cropping in order to straighten the slightly skewed angle of the flat cloud tops that were present in the original image. The contrast was then adjusted from zero to 50 in order to highlight the cloud edges and the feather cloud. A few small clouds visible on the edges of the photo were removed using the Spot Healing tool in order to focus more on the subject of the large altocumulus cloud. The original image and post processed image are shown top to bottom in the figure below.

Figure 4. Cloud image before (top) and after (bottom) post processing.

V. IMAGE ANALYSIS AND CONCLUSIONS

The image accurately captures an altocumulus cloud as well as an airplane contrail. The image reveals the smooth "UFO" shaped nature of this genus and the lenticularis species. The long smooth tops and proximity to mountains accurately depict the rising, cooling air overcoming an obstacle to form these type of clouds. Overall, the goals of the assignment were met. Some unanswered questions that could serve for future investigation to the image are to verify the translucidus variety. Further research could be done regarding the shape and color of altocumulus clouds in order to accurately describe the physics and leading characteristics of the cloud's proper variety. The cloud image could be improved by including the entire cloud in the frame when shooting the photo; at the present the upper left edge of the cloud is missing.

VI. REFERENCES

[1]Pretor-Pinney, Gavin. "The Cloudspotter's Guide." New York: Perigee, 2006.

[2]Oolman, Larry. "72469 DNR Denver Sounding." University of Wyoming. 2011. Accessed 2 February, 2011.<http://weather.uwyo.edu/cgibin/sounding?region=naconf&TYPE=GIF%3ASKEWT&YEAR=2011&MONTH=01&FROM=2900&TO=2900&STNM=72469>.